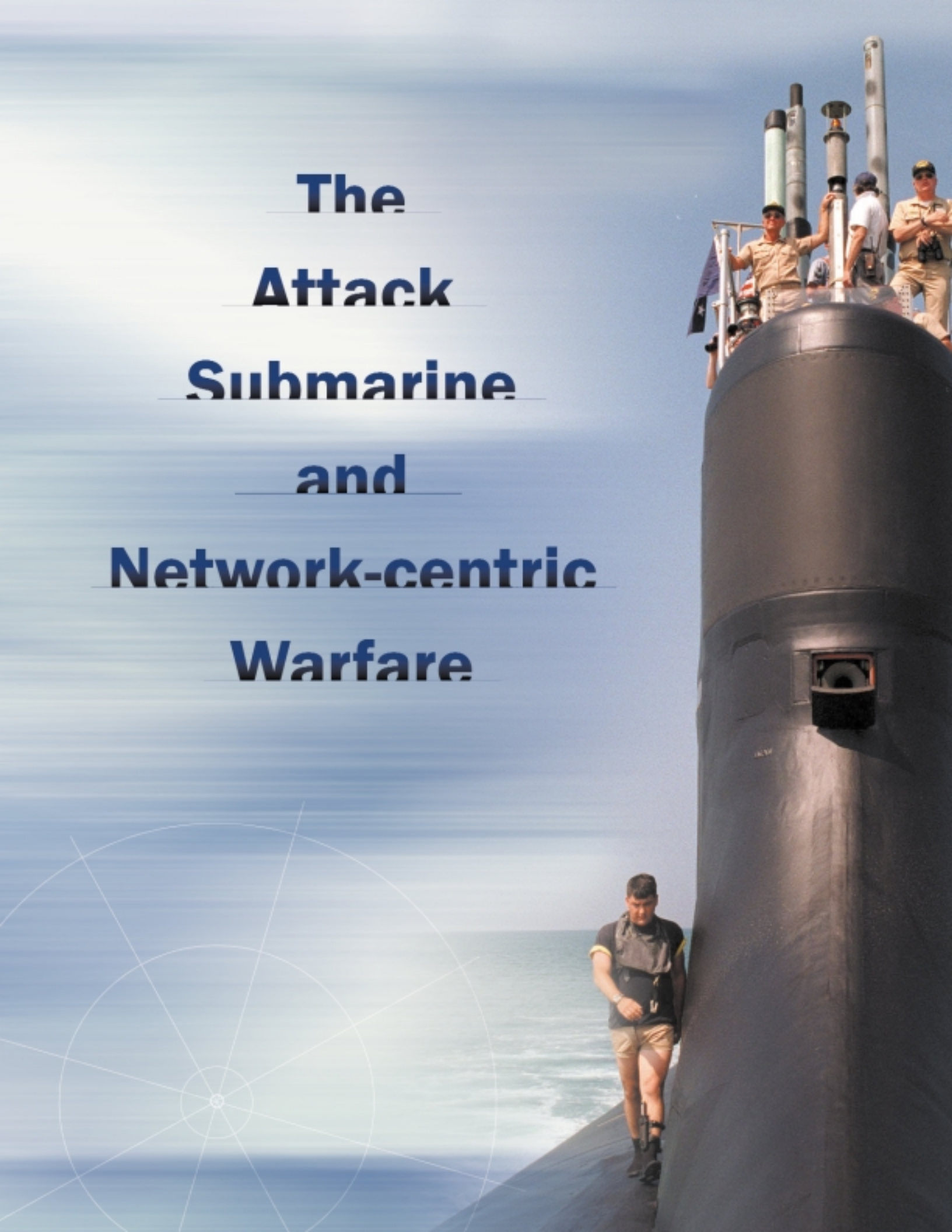
The Attack Submarine and Network-centric Warfare



Naval STRIKE FORUM

Submarines and Strike Warfare

Executive Summary

Submarines are the oldest major weapon system still in the U.S. military inventory, predating both fixed-wing aircraft and heavy armor. Their continued utility in modern warfare is attributable to a remarkable capacity to adapt to new warfighting requirements. Major steps in the submarine's evolution since World War II include the introduction of nuclear propulsion, long-range land-attack munitions, and advanced sensors for monitoring various developments ashore.

While Trident ballistic-missile submarines will remain the backbone of the U.S. nuclear deterrent for the foreseeable future, it is the more versatile attack submarine that is likely to play a growing role in conventional strike warfare. Because nuclear-powered attack subs combine stealth with long undersea endurance, they are able to safely gain access to regions where other U.S. military assets would be at risk. This access in turn enables them to collect many forms of valuable intelligence and to launch strikes against land targets with a maximum degree of surprise. The introduction of increasingly capable sensors and munitions, along with greatly improved communications links to other U.S. forces, suggest that attack submarines will become a key node for strike warfare in the littorals - perhaps the only node that can assure so high a level of survivability, versatility, precision and awareness.

However, the attack submarine's intrinsic virtues may be compromised by a failure to maintain adequate levels of force structure and new-ship construction. The Joint Chiefs of Staff have determined that regional commanders will need 68 attack subs by 2015 to meet peacetime security requirements, but satisfying that need requires expanding the current force structure of 56 operational attack subs by twenty percent. Unfortunately, projected levels of construction in the Navy's sole remaining submarine-production program - the Virginia-class - appear too low to close the gap, especially given the numerous retirements of older subs expected in the next decade. The United States thus faces a serious shortfall in future warfighting capabilities resulting from inadequate levels of investment in the attack-submarine program.

This white paper consists of two parts: a discussion of attack-submarine utility in strike warfare, and a discussion of attack-submarine availability. The first part was drafted by Phillip Thompson and the second part by Loren Thompson, both of the Lexington Institute staff. All members of the Naval Strike Forum had an opportunity to review and modify the final report.

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Submarines and the New Security Environment

When Charles Darwin formulated his theory of evolution, he wasn't thinking about the U.S. military. But there is a distinct similarity between evolution in the natural world and the capacity of military forces to adapt to changes in their environment.

Perhaps no weapons platform has shown a better ability to adapt than the attack submarine. Like its living counterpart, the shark, the submarine has since its genesis in the late nineteenth century evolved without drastically changing its original shape or purpose. And like the shark, the attack submarine remains the ultimate predator, a master of its deadly environment.

The evolution of the American submarine began even before World War I, when the United States' undersea-warfare capability was limited to the missions of harbor protection and warship escort.

During World War II, advances in technology enabled the Navy to build subs with quieter, more efficient engines, which gave the Navy a far greater reach. Moreover, with the capability to rig submarines for "silent running," the Navy had a stealth platform long before the phrase became fashionable.

Added to longer legs was better "sight." Improved periscopes, sonar, and the addition of radar allowed subs to be used for the first time as tactical sensors, "looking" for the enemy. This "sight" gave commanders a greater awareness of the battlespace around them, so much so that American subs - - two percent of the Navy's fleet - - accounted for most of the Japanese shipping sunk in the Pacific.

During the Cold War, attack subs reached a new level of lethality with the introduction of nuclear propulsion, which permitted nearly unlimited submerged endurance, enhanced stealth and the ability to rapidly transit between operational theaters with a much reduced logistics tail. Undersea weapons improved at a similarly rapid pace.

In addition, the most survivable leg of the nation's strategic nuclear deterrent was born in the form of ballistic-missile submarines (SSBNs in naval nomenclature). U.S. attack subs (SSNs) tracked Soviet ballistic-missile submarines at great risk, but with considerable success. The undersea-warfare community also built upon its World War II successes as a tactical-sensor platform. Quantum leaps in electronic technology allowed sub commanders to gather information that could be distilled into what was then called "indications and warnings" about U.S. adversaries. Little was said about these two attack-sub missions until recently.

Attack boats performed a variety of intelligence, surveillance and reconnaissance missions, many of which were wrapped in secrecy for so long that only now, over a decade after the collapse of the Berlin Wall, is it possible to grasp the complexity of these missions. Since the demise of the Soviet Union, such missions have increased in importance, scope and difficulty. Information has become the submarine's latest prey, as the monolithic Soviet threat is gradually replaced by more diverse national, international and transnational concerns.

Network-Centric Warfare

The attack sub has evolved from being primarily a hunter of other subs to a collector of information, which places the submarine community squarely in the center of "network-centric warfare," a force posture focused on the notion that future warfare will be defined largely by information networks. These networks of sensors, processors, and integrators will connect and coordinate the array of weapons platforms available to naval strike forces and the platforms of other services - - the Joint Surveillance and Target Attack Radar System (JSTARS), for example.

Because of their survivability, endurance and versatility, submarines possess enormous potential in the network-centric arena, especially in three areas: (1) access; (2) intelligence, surveillance and reconnaissance; and (3) strike warfare.

Access

Access to overseas areas of interest is the linchpin for submarine operations and, ultimately, for the entire battle force. Everything else a sub does or can do is predicated on the submarine's ability to first gain that access - - even in enemy-controlled waters and airspace.

In today's security environment, in which sophisticated area-denial capabilities are being developed and deployed by potential adversaries, American nuclear submarines are well-suited for covert access and preparation of the battlespace for follow-on joint forces.

A B-52 bomber, for example, is capable of gaining access, but cannot remain on station very long (time), nor is it especially covert (stealth). A B-2 has the advantage of stealth, but not necessarily time, as it is unable to remain on station for lengthy periods.

Satellites, by comparison, have exceptionally good "dwell times" or time on station. Thanks to geosynchronous orbits, some satellites can remain overhead indefinitely. But while there is an element of "covertness" to the positioning of satellites, sophisticated adversaries know that most intelligence satellites orbit the earth in regular patterns, traveling east to west. Thus, they can learn ways to avoid or deceive the satellite's gaze. And satellite positioning and instrumentation place limits on the type of intelligence that can be collected. The recent "surprise" of the Indian and Pakistani nuclear-weapons tests are proof of this.

Nuclear submarines, however, make the most of both time and stealth. When submerged, they are extremely difficult to detect and nearly impossible to track continuously. An adversary can thus never be certain whether an attack submarine's sensors are within listening range, or its weapons are within launching range. This element of doubt is a powerful deterrent to aggression.

Perhaps even more significant is the ability of subs to pave the way for surface battle groups into defended littoral waters. For example, submarines can neutralize enemy subs, locate mines, and destroy enemy missile batteries. Thus, submarines can thwart an enemy's strategy of sea denial.

The full exploitation of time and stealth produces "information and knowledge superiority," a modern version of Sun Tzu's tenet of "Know your enemy." It is in this realm of information superiority that the submarine's value becomes readily apparent.

Intelligence, Surveillance and Reconnaissance

Information-gathering tasks today are referred to as "intelligence, surveillance and reconnaissance" missions, or "ISR" missions. The ISR functions of an attack submarine are analogous to those of an electronic-eavesdropping satellite. Such satellites continuously orbit the earth, tapping into communications flows associated with troop movements, missile tests, terrorist attacks and the like.

But satellites orbit the earth in regular patterns, which makes their passage overhead predictable. Because satellites are predictable, they can be fooled. One way to limit trickery by adversaries is with geo-synchronous orbits, which allow satellites to remain over a designated

point on the Earth - - a missile field, for example. However, satellites in geosynchronous orbits are 22,000 miles above the earth, greatly limiting their ability to hear anything of interest.

Nuclear subs can operate at slow speeds and at depth to remain in place, undetected, near an adversary's coast for weeks or even months. They can tap undersea cables, monitor military frequencies, send special-operations forces ashore to conduct reconnaissance, and carry out a host of other intelligence missions without adversaries ever having any idea they are being scrutinized. And unlike spy satellites, subs can get very close to some targets to collect, process and transmit targeting data for a multitude of strike platforms. In fact, no other weapons platform in the U.S. inventory can guarantee access to the enemy's forces, communications and territory like a submarine.

It is nearly impossible to be certain when a submarine is in littoral waters. Once a sub leaves port, the saying goes, only two people know its location: God and the skipper. Unpredictability is a powerful force in warfare, because it causes the enemy to hesitate, guess, act rashly, or divert resources to defend against the mere possibility that a submarine is nearby. Under such circumstances, an adversary becomes less effective, and often self-deterring.

Strike Warfare

That is not to say that all submarines have to offer to network-centric warfare is a steady supply of targeting data or tactical intelligence. Because they carry Tomahawk cruise missiles, attack subs can use information generated from their own sensors or other sources to precisely attack land and sea targets hundreds of miles away.

Recent operations in the Persian Gulf and the Adriatic Sea, along with strikes against suspected terrorist camps in Afghanistan, clearly

demonstrated the submarine's ability to gain access to a theater and launch missiles against remote land targets, exploiting the timeless military advantage of surprise.

The role of attack subs in strike warfare is growing. During Operation Desert Storm, submarines fired four percent of the Tomahawk missiles launched against Iraqi forces. During the Kosovo campaign, subs fired 25 percent of all Tomahawks launched. The strike role of submarines could be further enlarged in the future, particularly as surface combatants are tasked to do more missions within a shrinking force structure, and as the dangers to surface ships operating in the littorals continue to proliferate.

An expanded strike role is facilitated by the modular-construction design of the next-generation Virginia-class attack submarine. Designed to be reconfigurable for a range of missions, the Virginia class carries ultra-sophisticated sensors and weapons whose warfighting potential is further bolstered by emerging payload technologies. As payloads become smaller and more efficient, and the submarine's sensory reach is extended, the submarine could emerge as a premier strike weapon.

The Jimmy Carter, a Seawolf-class submarine, has been redesigned with a larger, more flexible "ocean interface" payload compartment amidships. This hourglass-shaped payload section will enable crews to reconfigure the sub according to the mission and give the sub the ability to deploy sensors and payloads off board for classified missions. Such versatility, which in no way decreases the combat capabilities of the sub, gives fleet and unified commanders an exceptionally powerful asset when assigned any number of roles.
As an example, a lone submarine, loaded with Tomahawk missiles, can cruise ahead of a carrier battlegroup, undetected, until it reaches

a loiter point. Once on station, the sub can put ashore a team of special-operations troops to collect tactical intelligence while the sub crew collects information from its own sensors and shares the information with the joint task force and the National Command Authority. With targeting data thus developed, the sub can then launch a series of Tomahawk strikes against inland anti-aircraft missile and radar sites, effectively blinding the enemy and clearing the way for the joint task force and the carrier battle group. The submarine can then retrieve the special-operations force and resume patrol, or stay in the area to conduct ISR missions in support of the battle group.

Regional commanders consider the ISR mission of attack submarines so crucial that the demand for mission-days is outstripping the supply of subs. This was foreshadowed in a recent study of sub requirements sponsored by the Chairman of the Joint Chiefs of Staff. The 1997 Quadrennial Defense Review mandated a budget-constrained attack-sub fleet of 50 boats. However, the Joint Chiefs' study determined 68 attack subs would be needed by 2015 to carry out the most critical peacetime missions, a level that many officials, both in and out of the Navy, feel may be impossible to reach without drastically increasing current submarine construction.

Connectivity Constraints

Submarines face an operational challenge. Attack subs normally operate underwater, a medium whose physics make transmission of data at speeds required for network-centric warfare difficult. In addition, the use of large antennas, rigidly attached to submarine masts, forces trade-offs to be made with submarine stealth. These issues pose a significant challenge to the undersea-warfare community, which needs to participate in the exchange of information that creates a "common operational picture" - - a comprehensive, shared view of the battlespace.

Space and stealth considerations have limited submarine antenna aperture and bandwidth, constraining information flows. Simply put, submarines must be capable of transmitting and receiving data - - including high-quality images that could be used for targeting - - at speeds equivalent to forces on the surface. Current transmission rates enable sub crews to accomplish most tasks and to utilize the Global Positioning System. But existing rates are not sufficient for receiving all the data needed to optimize the use of land-attack weapons.

The Navy is developing next-generation antenna technology that upgrades existing internal and external systems to bring submarines into the world of network-centric warfare. An Extremely High Frequency, or EHF, antenna was installed aboard the USS Pasadena two years ago to give the sub a greater capability to work with carrier battle groups. The EHF systems will improve direct communication between submarine and aircraft carrier.

There are several potential solutions to the bandwidth dilemma, mostly conceptual. One possible answer is a phased-array antenna for submarines similar to the Aegis radar used on surface ships such as the Ticonderoga-class cruisers and Arleigh Burke-class destroyers. Also, floating antennas may provide a means of information exchange without sacrificing a submarine's stealth. Advanced floating antennas are currently in the demonstration phase. They allow two-way UHF satellite communications at high data rates with submarines at operational depths.

A Force Multiplier for the Future

The ability of undersea warships to gain prolonged and secret access to potentially hostile regions, combined with their capability to collect and exploit many forms of intelligence, makes attack submarines a valuable force multiplier in strike warfare. These intrinsic virtues are being further leveraged through the introduction of increasingly accurate and flexible land-attack munitions, and the development of improved communication links that allow the submarine to be more responsive to rapidly changing warfighting requirements.

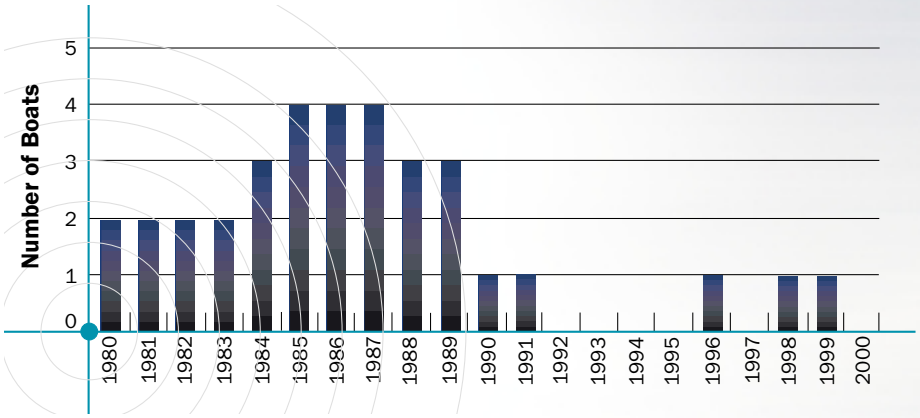
As submarines become increasingly integrated into joint and coalition warfighting forces, their survivability and versatility assure they will become a key node in network-centric warfare. It is therefore essential that the nation maintain an adequate force of modern, well-equipped attack submarines.

The Challenge of Submarine Availability

Although the utility of nuclear-powered attack submarines in various aspects of strike warfare is now well established, the availability of an adequate undersea force is not. Over the past decade, the number of attack submarines in the active force declined 40 percent, from 92 boats in 1990 to 56 in 2000. During the same period, intelligence-gathering and surveillance taskings for the undersea fleet doubled, largely as a result of increased demand from national-level authorities. Two-thirds of all submarine mission days are now dedicated to ISR activities for the fleet, theater commanders, and the national intelligence community.

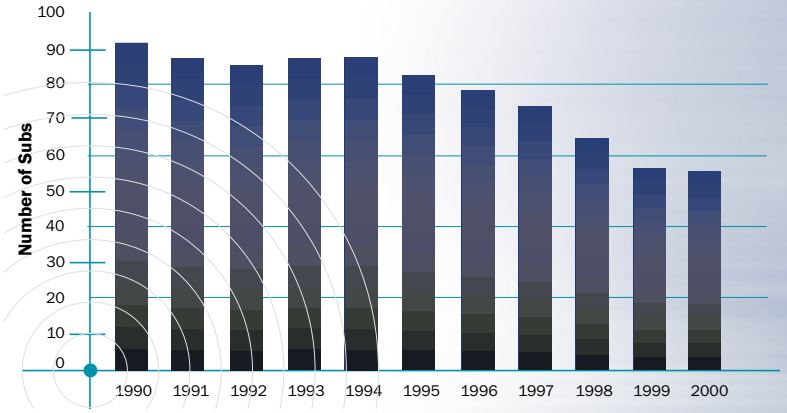
The existing fleet of attack subs is not capable of accommodating this level of demand while also discharging its other mission responsibilities. One indication of the shortfall in capabilities is that 365 mission days of requested intelligence gathering had to be deferred in 1999

U.S. Attack Submarine Production Since 1980



due to more pressing operational needs. The same problem occurred in 2000. Because ISR taskings are expected to continue expanding, there is an active debate under way as to how the size and productivity of the force might be enhanced.

40% Fewer Attack Subs Since 1990



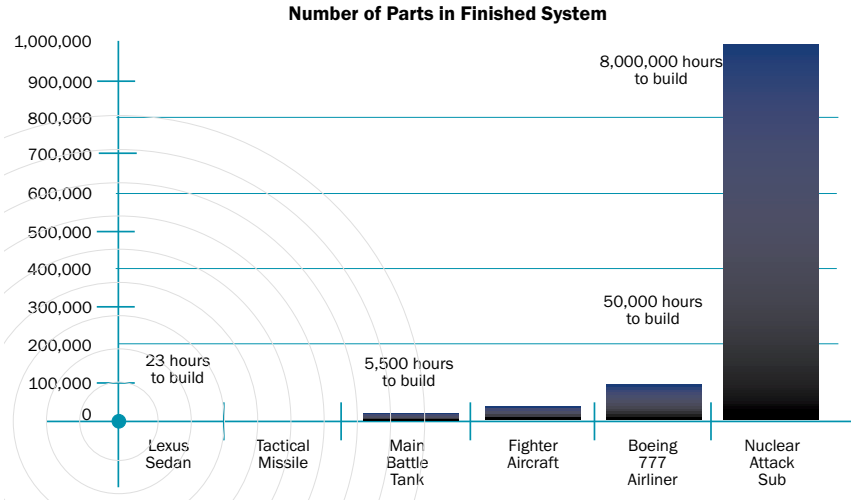
A recent study by the Joint Chiefs of Staff concluded that the Navy needed 68 attack subs by 2015 in order to satisfy the most critical peacetime requirements likely to be generated by regional commanders around the world. This estimate did not include the demand for strike missions in wartime, but it is a reasonable point of departure for assessing force adequacy since the Navy would probably suspend many peacetime activities once hostilities commenced and surge deployed forces to a significantly higher level of availability.

There are basically three ways of closing the performance gap between the current inventory of 56 attack subs and the projected requirement of 68: build more subs, refuel existing subs, and increase the productivity of existing subs. In a world unconstrained by budgetary considerations, building more subs would clearly be the preferred option. First of all, the current Virginia-class of attack subs is more versatile and flexible than earlier generations of subs. Second, it is also more stealthy, and the Joint Chiefs have emphasized that Virginia-class levels of quieting will become increasingly necessary in the future to operate in littoral waters (their study calls for 18 Virginia-class boats by 2015). Third, most of the installed inventory of attack subs must be retired over the next 30 years due to irreversible aging in their structural elements and propulsion systems.

The construction plan of record for the Virginia-class envisions transitioning from one boat per year (the present rate) to two later in this decade, and eventually alternating between two and three per year. Even when coupled with recent three-year service-life extensions on some Los Angeles-class subs and the refueling of seven Los Angeles-class submarines scheduled for inactivation, that profile would not enable the Navy to reach the necessary level of 68 attack subs specified by the Joint Chiefs. Also, it would not come close to attaining the higher number of boats expected to be needed in 2025, nor would it leave much slack for coping with attrition or unanticipated requirements. Refueling of the seven Los Angeles-class submarines and conversion of four Trident-class ballistic-missile subs to conventional land-attack boats is necessary, but even with these subs, the Navy will fall short of the Joint Staff requirement.

For all of those reasons, the Navy has begun an intensive investigation of ways in which the productivity of existing submarines might be increased. Attack subs today are typically available on station for

Submarines: Most Complex System



military missions only part of their lifetimes. The remaining time is spent on training missions, in transit to mission areas, and in repair and replenishment. By reducing the time spent on other activities, it might be possible to substantially increase the mission-availability of each boat.

One possibility discussed in the media that would not work is to provide attack subs with dual crews, as is already done for Trident ballistic-missile subs. The Navy estimates it would take a decade to recruit and train additional crews, and even then the availability of each sub would only increase 40 percent due to time required for training, transit and repair/replenishment. A completely different approach to training would have to be implemented, since subs would not be as available for training at sea as they are today. The Trident program solves that problem by using simulators and other learning aids ashore that cover every facet of the Trident mission during the 77-day off-crew period. However, that method would not work with attack subs, which have much more complex mission requirements than the single-mission Tridents and would involve a much longer off-crew period (about one year).

The most fundamental drawback to dual crews, though, it that they would not really solve the shortfall in capabilities, only defer it. Even if it were feasible to close the current 20 percent shortfall in submarine force structure through dual-crewing, this would be achieved by accelerating the operating tempo of each sub and thus reducing its projected service life. The likely reduction in service life would be about 20 percent - - from 30 years to 24 years.

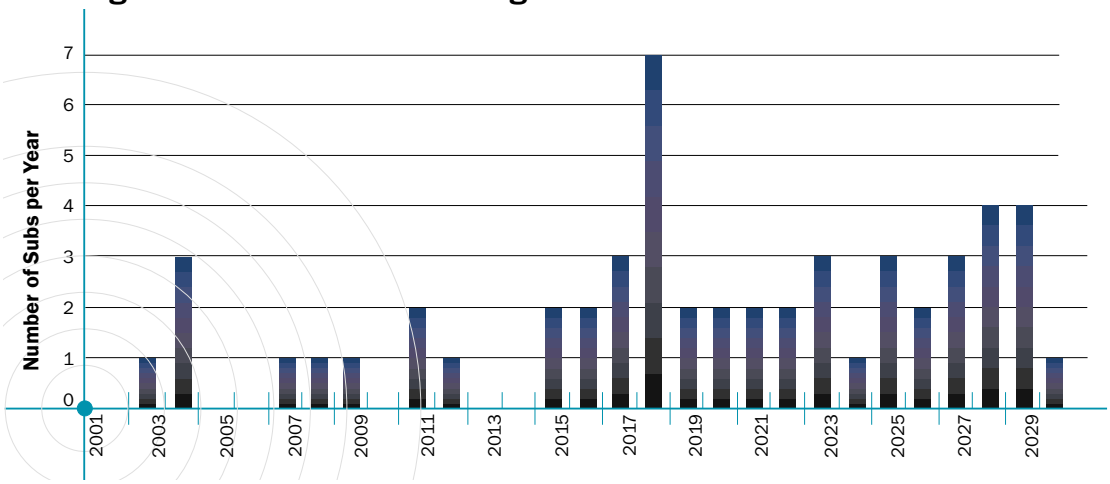
Thus, over the long run a dual-crew system would simply pass on the force-structure shortfall to another generation. While such generational transfers of defense burdens have become commonplace during the "procurement holiday" of the 1990s, they are an irresponsible way of maintaining military preparedness.

Other methods of bolstering submarine productivity look somewhat more promising. One would be to forward-deploy attack subs closer to theaters of operation, reducing transit times between homeports and mission areas. This would be unattractive if it involved relying on facilities under the control of foreign governments, but the United States does have overseas possessions such as Guam in the western Pacific that might afford the benefits of forward deployment while still being secure. Unfortunately, properly equipping forward sites to support nuclear-powered attack subs would be expensive, and their availability might still be compromised at some future point due to local political considerations. Nonetheless, the potential gain in mission days is so great that the Navy should seriously consider such an approach.

It might also be feasible to further extend the lives of Los Angeles-class attack subs to supplement the undersea fleet. The Navy has already decided to extend the service life of some subs ten percent

beyond their intended 30 years, and additional increments of service are at least theoretically feasible. However, this would require considerable research to verify, and there would always be some margin of uncertainty as to whether a sub operating beyond its intended service life was still safe.

Los Angeles-Class Decommissioning Schedule



It may be possible to adjust safety thresholds for such processes without materially increasing the danger to crew or vessel. Even if it were though, this would hardly be an ideal solution, because old submarines are inherently harder to maintain, and the marginal gains in service life might not justify all the associated costs.

As this brief review of options implies, there is no cheap and easy way of filling the gap in submarine forces. Transitioning to construction of multiple ships per year earlier would help mitigate the numbers problem and result in lower unit costs for the ships. Additionally, innovative contracting approaches such as block buys, economic-ordering-quantity buys for material, or multiyear buys would further reduce unit cost. For example, industry estimates show ten Virginia-class ships can be obtained for the price of nine under a multiyear commitment running five years with production of two vessels annually.

In the end, some administration will still need either to build submarines at a faster rate or accept a permanent shortfall in military capabilities. That shortfall is already emerging today, but may look a good deal more ominous in the future if threats to national security increase.

Survival of the Fittest

As the attack submarine begins its second century of service in the U.S. Navy, it looks more useful to future warfighters than many other platforms of lesser age. By constantly evolving its technology and missions to meet the needs of new generations, the attack sub has remained not merely relevant, but essential.

No human institution more closely resembles the unforgiving evolutionary logic of the natural world than warfare, and in that arena the submarine continues to thrive. Over time, it has become more survivable, more versatile, and more lethal. Few of its rivals can make such a claim.

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1655 North Fort Myer Drive • Suite 325
Arlington, Virginia 22209
Phone: 703.522.5828 • Fax: 703.522.5837

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